Niagara Mohawk Power Corporation

Subcontractor:	Niagara Mohawk Power Corporation 300 Erie Boulevard West Syracuse, NY 13202
Contracting Party:	Midwest Research Institute, National Renewable Energy Laboratory Division
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1.0 Project Summary

Background

Niagara Mohawk Power Corporation (NMPC) will invest nearly $2 million during 1999 to retrofit its Dunkirk Steam Station to co–fire approximately 10 MW of biomass with coal. Co–firing has long been a goal for the Dunkirk Station owners and is seen by the new plant manager as an important added value capability as the station is transferred from NMPC to NRG in the summer of 1999. As the lead organization for the Salix Consortium, NMPC works with 20 organizations in the Northeast to scaleup and demonstrate the viability of willow energy crops. This is the second leg of the NMPC program to demonstrate sustainable future energy supplies of biomass for power generation. The third leg of NMPC plans for biomass is the development of viable distributed power systems to support the grid where load growth and biomass resources converge. The proposed objective of this feasibility study was to develop a system (components and configuration) from commercially available technologies and to evaluate costs and benefits of operating the system in NMPC's service area.

In Phase I, we proposed to explore the feasibility of biomass gasifiers for two potential near-term markets: 1) grid support for power distribution in rural locations, and 2) co–location at large-scale power generation facilities to provide NO_x control and fuel flexibility. After preliminary work, the focus of the effort became grid support, or distributed generation, applications. The distributed generation systems in remote areas would be a better fit with NMPC's role in the restructured electricity market. It also appears to be a lower risk application with very near-term applicability.

Rural Service Markets for Biomass Support to Transmission and Distribution

A distributed generation facility located at the end of the grid may be able to deliver power competitively using locally available biomass resources. In the not-too-distant future, remote customers may have to bear more of the cost of service than they do today as the electric markets are deregulated. A distributed generation system will not have to be burdened with the full charge for transmission. Biomass distributed generation may become more competitive under these circumstances, even though much cheaper power may be available at power exchanges.

The area selected by NMPC for a site–specific evaluation of the market for biomass–fueled gensets is representative of many of the rural areas bordering the Appalachian chain In the opinion of CT Donovan Associates and Tim Volk, State University of New York Environmental Services and Forestry, the volume of resources in this region can be replicated in many areas of Pennsylvania, New York, Vermont, New Hampshire, and Maine. In the northern tier of this region a number of biomass–fueled generating plants built during the

1970s helped establish an infrastructure for biomass energy supplies. The retirement of some of these stations is creating a situation in which fuel suppliers will need to find buyers or close their operations. This situation has created near–term opportunities to acquire fuels for new projects at very competitive prices. The opportunity to pick up the slack in business will fade as suppliers adjust to the market.

The cost of upgrading transmission and distribution to communities served by radial feeders in the Adirondack area is $4 to $8 million. A generation system using local fuels would be an attractive alternative to reconducting the transmissions lines if capital requirements were the same or less, and the (levelized) COE was competitive. The use of reliable distributed generation technology would mean that the needed capacity could be added without disrupting service during construction. System reliability would improve because these rural customers could be served by two independent sources much the same way that transmission loops often provide two routes to reach the customer.

Technology and Application Economics for Grid Support Applications

Although this study discovered significant outstanding technical issues with gasification and its use with engine systems, the design and costing of a system was undertaken to understand the economics of a 5-MW biomass power plant built with currently available equipment. The power plant would be composed of the gasifier, gas turbine and generator, wood receiving facility, a stockyard, sizing equipment, a rotary wood dryer, storage silo, and a substation. The plant is assumed to be located somewhere in the Adirondack Park region in one-half mile of a distribution substation.

This plant is intended for base load duty to maximize utilization and thus lower costs. The system design began with the premise of generating a nominal 5 MW_e capacity. The net output of the plant turned out to be 4.27 MW after plant parasitic uses. As a base loaded plant, the capacity utilization was assumed to be 90% or better.

The Primenergy gasifier is used as the basis of the system. This system requires that the wood feed have a moisture content (MC) of 20% or less. Because a large portion of the wood supply will be whole green chips and bark, a dryer is required. A gas turbine generator was chosen over a spark ignition reciprocating engine generator because it has lower capital and operating costs. A Solar Turbine's Taurus 60, rated at 52000 kW ISO base load, was chosen as a representative model. To complete the plant, a substation is required to step up the voltage to tie into the distribution system. Total capital requirements are an estimated $15 million.

Table 10.

Gross output	5.2 MW
Net output	4.27 MW
Annual net output	33,633 MWh
Capacity utilization	90%
Annual operating hours	7884
Fuel	Wood residues
Fuel consumption	103,000 green tons/yr

At this point, NMPC realized that building a modular 5-MW system for stand-alone electricity service from today's off-the-shelf equipment would not be cost competitive with the line upgrade alternative. Given the significant technical issues with gasifiers of that capacity and their coupling with a turbine or reciprocating engine, a successful demonstration of this scale of application could be undertaken within the next 5 years seemed unlikely. A major technical development and demonstration effort would have to be mounted to build a system in the near term that would satisfy NMPC standards for service.

Despite this conclusion, a financial analysis was conducted to complete the feasibility study. A levelized revenue requirement calculation was performed for the base case (building in the near term with currently available equipment with current wood prices). Several scenarios were run from the base case to illustrate the impact of capacity utilization, wood cost, and total capital requirements. Finally, an analysis was performed to establish cost and performance goals for future systems. A best case system was developed by optimistically cutting costs and improving performance in every area available.

The calculated COE for the base case is 16.28¢/kWh, mostly because of the high costs of handling, sizing, and drying the wood. Because of the labor required and the maintenance of the equipment, the O&M costs comprise more than half the COE.

The COE for the future system design is 8.2¢/kWh with $14.00/green ton wood, of 5.9¢ with zero cost wood. A capital investment of $10.5 million is required. This is considerably closer to providing an alternative to the line upgrade option. However, capital requirements still exceed the transmission line upgrade, and the COE exceeds, albeit slightly, the rates established for the Adirondack Park region. Lastly, achieving this level of cost with the attendant expectation of higher performance and high reliability and availability is likely to be a large undertaking.

Conclusions

NMPC remains very interested in the development of an advanced, cost-effective biomass modular generation technology that uses local resources. The cost of upgrading radial feeders in rural, environmentally sensitive areas will require significant company investment during the next 10 years. However, we have concluded that biomass gasification systems are not technically or economically ready to provide a viable alternative to reconducting. The efficiency of the gasifiers must be improved and their reliability demonstrated before these systems can be considered ready for service. Much of the required work is underway, and we hope that DOE can continue to support these efforts.

Although NMPC is not prepared to assume a primary R&D role at this juncture, we would be open to partnering with a technology developer and others when the technology is ready for a pre-commercial demonstration.